



- SIP-package fits existing TO-220 footprint
- Suitable for positive & negative output circuit
- Pin compatible with LMxx linear regulators
- Built in filter capacitors
- Operation temp. range  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$
- No heat-sink required
- Over-temperature & short circuit protection
- Wide input range up to 36 VDC
- Excellent line/load regulation
- 3-year product warranty



The new TSRN 1 series step-down switching regulators are drop-in replacement for inefficient 78xx linear regulators. A high efficiency up to 95% allows full load operation up to  $+70^{\circ}\text{C}$  ( $+85^{\circ}\text{C}$  with derating) ambient temperature without the need of any heat-sink or forced air cooling. The TSRN-1 switching regulators provide other significant features over linear regulators, i.e. better output accuracy ( $\pm 2\%$ ), lower standby current of  $\sim 2$  mA and no requirement of external capacitors. They are suitable for positive or negative output circuits. The high efficiency and low standby power consumption make these regulators an ideal solution for energy sensitive applications.

Models				
Order Code	Output Current max.	Input Voltage Range	Output Voltage nom.	Efficiency typ.
TSRN 1-2415	1'000 mA	4.6 - 36 VDC (12 VDC nom.)	1.5 VDC	77 % (at Vin min.)
TSRN 1-2418			1.8 VDC	81 % (at Vin min.)
TSRN 1-2425			2.5 VDC	84 % (at Vin min.)
TSRN 1-2433			3.3 VDC	88 % (at Vin min.)
TSRN 1-2450			5 VDC	92 % (at Vin min.)
TSRN 1-2465			6.5 VDC	93 % (at Vin min.)
TSRN 1-2490			9 VDC	95 % (at Vin min.)
TSRN 1-24120		12 VDC	95 % (at Vin min.)	
TSRN 1-24150		15 VDC	96 % (at Vin min.)	
			6.5 - 36 VDC (12 VDC nom.)	
		8 - 36 VDC (12 VDC nom.)		
		10.5 - 36 VDC (12 VDC nom.)		
		13.5 - 36 VDC (24 VDC nom.)		
		16.5 - 36 VDC (24 VDC nom.)		

Options	
Suffix A	- Optional models with angular pins (see outline dimensions)

Note - For external circuit proposal for negative output voltage, refer to application note: [www.tracopower.com/overview/tsrn1](http://www.tracopower.com/overview/tsrn1)

### Input Specifications

Input Current	- At no load	12 Vin models: <b>2 mA typ.</b> 24 Vin models: <b>3 mA typ.</b>
Reflected Ripple Current		<b>100 mAp-p typ.</b>
Recommended Input Fuse		12 Vin models: <b>2'000 mA (slow blow)</b> 24 Vin models: <b>2'000 mA (slow blow)</b> (The need of an external fuse has to be assessed in the final application.)
Input Filter		<b>Internal Capacitor</b>

### Output Specifications

Voltage Set Accuracy		<b>±2% max.</b>
Regulation	- Input Variation (Vmin - Vmax) - Load Variation (10 - 100%)	<b>0.2% max.</b> <b>0.6% max.</b> (1.5 Vout models, straight pin vers.) <b>1.2% max.</b> (1.5 Vout models, angular pin vers.) <b>0.4% max.</b> (1.8 Vout models, straight pin vers.) <b>1.2% max.</b> (1.8 Vout models, angular pin vers.) <b>0.4% max.</b> (other output models, both pin vers.)
Ripple and Noise (20 MHz Bandwidth)		24 Vin models: <b>75 mVp-p max.</b> 1.5 Vout models: <b>50 mVp-p max.</b> 1.8 Vout models: <b>50 mVp-p max.</b> 2.5 Vout models: <b>50 mVp-p max.</b> 3.3 Vout models: <b>50 mVp-p max.</b> 5 Vout models: <b>50 mVp-p max.</b> 6.5 Vout models: <b>50 mVp-p max.</b> 9 Vout models: <b>75 mVp-p max.</b>
Capacitive Load		<b>470 µF max.</b>
Minimum Load		<b>Not required</b>
Temperature Coefficient		<b>±0.015 %/K max.</b>
Start-up Time		<b>5 ms typ.</b>
Start-up Overshoot Voltage		<b>1% max.</b>
Short Circuit Protection		<b>Continuous, Automatic recovery</b>
Output Current Limitation		<b>200% typ. of Iout max.</b>
Transient Response	- Peak Variation - Response Time	<b>150 mV typ. / 250 mV max. (50% Load Step)</b> <b>250 µs typ. / 350 µs max. (50% Load Step)</b>

### EMC Specifications

EMI (Emissions)	- Conducted Emissions  - Radiated Emissions	<b>EN 55032 class A (with external filter)</b> <b>EN 55032 class B (with external filter)</b> <b>EN 55032 class A (with external filter)</b> <b>EN 55032 class B (with external filter)</b>
		External filter proposal: <a href="http://www.tracopower.com/tsrn1-emc-filter">www.tracopower.com/tsrn1-emc-filter</a>

### General Specifications

Relative Humidity		<b>95% max. (non condensing)</b>
Temperature Ranges	- Operating Temperature - Case Temperature - Storage Temperature	<b>-40°C to +85°C</b> <b>+100°C max.</b> <b>-55°C to +125°C</b>
Power Derating	- High Temperature	<b>Depending on model</b> See application note: <a href="http://www.tracopower.com/tsrn1-cc">www.tracopower.com/tsrn1-cc</a>
Over Temperature Protection Switch Off	- Protection Mode - Measurement Point	<b>170°C typ. (Automatic recovery)</b> <b>Internal IC temperature</b>
Cooling System		<b>Natural convection (20 LFM)</b>
Regulator Topology		<b>Buck Converter</b>

All specifications valid at nominal voltage, resistive full load and +25°C after warm-up time, unless otherwise stated.

Switching Frequency		240 - 360 kHz (PWM) (1.5 - 3.3 Vout models) 464 - 696 kHz (PWM) (5 - 15 Vout models)
Insulation System		Non-isolated
Reliability	- Calculated MTBF	20'000'000 h (MIL-HDBK-217F, ground benign)
Washing Process		According to Cleaning Guideline <a href="http://www.tracopower.com/info/cleaning.pdf">www.tracopower.com/info/cleaning.pdf</a>
Environment	- Vibration  - Mechanical Shock  - Thermal Shock	MIL-STD-810F EN 61373 MIL-STD-810F EN 61373 MIL-STD-810F
Housing Material		Non-conductive Plastic (UL 94 V-0 rated)
Potting Material		Silicone (UL 94 V-0 rated)
Pin Material		Copper
Pin Foundation Plating		Nickel (2 - 3 µm)
Pin Surface Plating		Tin (3 - 5 µm), matte
Housing Type		Plastic Case
Mounting Type		PCB Mount
Connection Type		THD (Through-Hole Device)
Footprint Type		SIP3
Soldering Profile		Lead-Free Wave Soldering 265°C / 10 s max.
Weight		1.9 g
Environmental Compliance	- REACH Declaration  - RoHS Declaration  - SCIP Reference Number	<a href="http://www.tracopower.com/info/reach-declaration.pdf">www.tracopower.com/info/reach-declaration.pdf</a> REACH SVHC list compliant REACH Annex XVII compliant <a href="http://www.tracopower.com/info/rohs-declaration.pdf">www.tracopower.com/info/rohs-declaration.pdf</a> Exemptions: 7(a), 7(c)-I (RoHS exemptions refer to the component concentration only, not to the overall concentration in the product (O5A rule.)) e4ce8d4a-97c4-4c02-aa67-5cdd9298da13

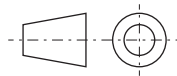
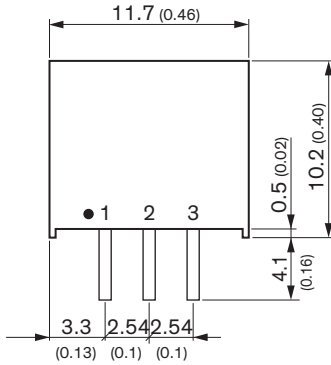
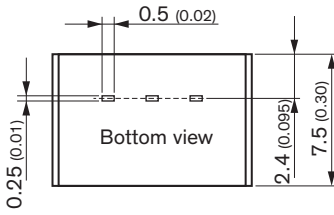
### Additional Information

Supporting Documents	<a href="http://www.tracopower.com/overview/tsrn1">www.tracopower.com/overview/tsrn1</a>
Frequently Asked Questions	<a href="http://www.tracopower.com/glossary-faq">www.tracopower.com/glossary-faq</a>
Glossary	<a href="http://www.tracopower.com/info/glossary.pdf">www.tracopower.com/info/glossary.pdf</a>

All specifications valid at nominal voltage, resistive full load and +25°C after warm-up time, unless otherwise stated.

## Outline Dimensions

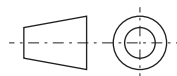
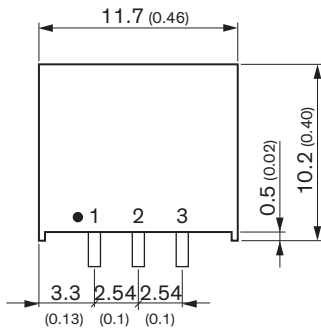
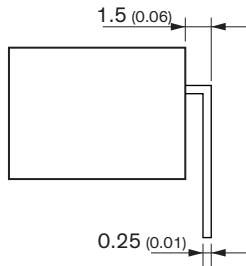
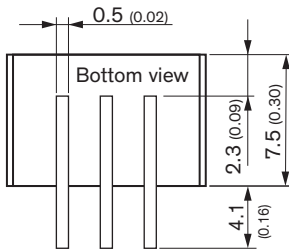
### Straight pin version (Standard)



Dimensions in mm (inch)  
 Tolerances: x.xx ±0.5 (x.x ±0.02)  
 Tolerances: x.xxx ±0.25 (x.xx ±0.01)  
 Pin pitch tolerances: ±0.25 (±0.01)  
 Pin dimension tolerances: ±0.1 (±0.004)

Pinout	
Pin	Function
1	+Vin
2	GND
3	+Vout

### Angular pin version (Suffix A)



Dimensions in mm (inch)  
 Tolerances: x.xx ±0.5 (x.x ±0.02)  
 Tolerances: x.xxx ±0.25 (x.xx ±0.01)  
 Pin pitch tolerances: ±0.25 (±0.01)  
 Pin dimension tolerances: ±0.1 (±0.004)

Pinout	
Pin	Function
1	+Vin
2	GND
3	+Vout

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